Industrial & Institutional Attachment
EC 710

Practical : 6 | **Year: IV**
Part: I

Course Objective:

1. To visit and work in process industries in Nepal or abroad.
2. To participate in research in the institute or university in Nepal or abroad.

General Procedures:

Students in groups will be placed in chemical industries/research institute /academic institutions for the maximum duration of two months. There will be in total two supervisors assigned, one from Department of Applied Sciences and Chemical Engineering, and the other one from Industry or Academic institute. Supervisor from the industry should be an engineer/technologist. In case of Industry, students need to understand chemical principles related to manufacturing processes. Whereas, in case of Academic, students should actively participate in any ongoing research related to Chemical Engineering.

After the completion of their attachment, each group has to submit the report and give presentation to the committee formed by the department.

Reports from the Industry should include overall process description. Reports from the academics should include short research project conducted by the group.

Evaluation Scheme:

The evaluation scheme will be indicated in the table below:

	Marks
Evaluation by supervisor from industry/research institute	40
Internal evaluation	60
Total	100

Maintenance Engineering and Safety
EC 707

Lecture: 3 **Year: IV**
Tutorial: 1 **Part: I**

Course Objective:

i. To learn different types of maintenance systems and its uses in chemical process plant
ii. To help students in understanding safety concepts and identifying major hazards.

1. Maintenance: Concept (5 hours)

1.1 Introduction
1.2 Maintenance types, breakdown, planned , preventive, total productive
1.3 Condition-monitoring techniques

2. Maintenance planning and scheduling: (10 hours)

2.1 Introduction
2.2 Manpower Allocation
2.3 Planning technique and procedure
2.4 Short and long term planning
2.5 Economic aspects of maintenance, maintenance cost
2.6 Computerized maintenance
2.7 Equipment maintenance
 2.7.1 Lubrication and lubricants
 2.7.2 Maintenance of rotary and stationary equipment, cooling tower

3. Safety: Introduction (4 hours)

3.1 Process safety
3.2 Accident and loss statistics
3.3 Nature of the accident process
3.4 Inherent safety
3.5 Case studies – Industrial disasters through secondary sources

4. Toxicology (6 hours)

4.1 Toxic materials and its route and effect to biological organisms
4.2 Dose response relationships
4.3 Threshold limit values
4.4 Material safety data sheets
4.5 Evaluating exposures to volatile toxicants by monitoring
4.6 Personal protective equipment, respirators, ventilations
4.7 Hazards and operability studies (HAZOP)

5. Source Models and Dispersion (6 hours)

5.1 Leakage of liquid and gas through holes, pipes and fittings
5.2 Flashing liquids, liquid pool evaporation or boiling
5.3 Parameters affecting dispersion
5.4 Dispersion models, Pasquill-Gifford plume and puff model

6. Fires and Explosions (8 hours)

6.1 Fire triangle, fires and explosions, flammability of liquids and vapors
6.2 Limiting oxygen concentration, flammability diagram
6.3 Ignition Energy, Sprays and Mists
6.4 Explosions, detonation and deflagration, TNT equivalency, energy of chemical explosions
6.5 Inerting, vacuum purging, pressure purging
6.6 Static electricity and its controlling techniques
6.7 Ventilation and sprinkler systems to prevent fire and explosion

7. Relief systems (4hours)

7.1 Definition, location, types, scenarios
7.2 Horizontal knockout drum, flares, scrubbers and condensers
7.3 Relief selection for vapor/gas, liquid and runway reaction services

8. Risk Assessment (2 hours)

8.1 Probability theory
8.2 Event trees and fault tree analysis

References:

1. R. C. Mishra, K. Pathak, “Maintenance Engineering and management”, PHI learning Pvt. Ltd., India.
2. D. A. Crowl, J. F. Louvar, “Chemical Process Safety: Fundamentals with Applications, Pearson Education India.
3. S. Banarjee, “Industrial Hazards and Plant Safety”, Taylor & Francis, New York, 2003.
4. L. M. Deshmukh, “Industrial Safety Management,” McGraw Hill Education.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 3	all	16
2	2	all	16
3	4 & 7	all	16
4	5 & 8	all	16
5	6	all	16
Total			80

Process Economics and Plant Design
EC 708

Lecture: 3 **Year: IV**
Tutorial: 1 **Part: I**

Course Objective

i. To provide the fundamentals of economics, scale up methods and design.

1 Time value of money: (4 hours)

1.1 Interest, compounding and discounting factors, loan payments
1.2 Cash flow pattern: discrete cash flow, continuous cash flow.

2 Methods for calculating profitability (6 hours)

2.1 Methods that do and do not consider the time value of money
2.2 Alternative investments by different profitability methods
2.3 Effect of inflation on profitability analysis
2.4 Methods of profitability evaluation for replacements.

3 Depreciation (4 hours)

3.1 Straight line, declining balance, double declining balance, sum-of-the-years-digit, sinking fund

4 Analysis of cost estimates (8 hours)

4.1 Factors affecting investment and production costs
4.2 Capital investment, types of capital cost estimates
4.3 Methods for estimating capital investment
4.4 Estimation of revenue
4.5 Estimation of total product cost
4.6 Gross profit, net profit and cash flow
4.7 Contingencies.

5 Optimum design and design strategy (10 hours)

5.1 Procedure with one, two and more variables
5.2 Optimum production rates in plant operation
5.3 Case studies
5.4 Integer programming, dynamic programming for optimization
5.5 Application of Lagrange multipliers
5.6 Method of steepest ascent or descent.

6 Plant location and layout (4 hours)

6.1 Factors for selection of plant location
6.2 Site selection and preparation
6.3 Plant layout and installation

7 Scale-up (9 hours)

7.1 Pilot plants and models
7.2 Principle of similarity
7.3 Dimensional analysis
7.4 Empirical and semi-empirical model building
7.5 Regime concept: static regime, dynamic regime
7.6 Similarity criteria and scale equations for important equipments.

References:

1. M. S. Peters, K. D. Timmerhaus, R. E. West, "Plant Design and Economics for Chemical Engineers", McGraw Hill, 2002.
2. G. Towler, R. K. Sinnott, "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", Butterworth-Heinemann, 2012.
3. R. Turton, R. C. Bailie, W. B. Whiting, J. A. Shaeiwitz, D. Bhattacharyya, “Analysis, Synthesis, and Design of Chemical Processes”, Prentice Hall, Pearson.
4. J. R. Couper, "Process Engineering Economics (Chemical Industries)", CRC Press, 2003.
5. M. Zlokarnik, "Scale-up in Chemical Engineering", Wiley-VCH, 2006.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	16
2	3 & 6	all	16
3	4	all	16
4	5	all	16
5	7	all	16
Total			80

Modeling and Simulation in Chemical Engineering
EC 706

Lecture: 3 **Year: IV**
Tutorial: 1 **Part: I**
Practical: 1.5

Course Objective

i. Introduce the concepts of modeling and simulation
ii. Train the students to develop a model
iii. Identify simple and complex models in Chemical Engineering
iv. Ability to incorporate modeling and simulation in problem-solving

1 Introductory Concepts **(8 hours)**
1.1 Modeling and simulation
1.2 Types of simulation
1.3 Application of simulation in Chemical Engineering
1.4 Steps in development of models
1.5 Classification of models
1.6 Simplifying concepts

2 Basic Models **(8 hours)**
2.1 Models based on law of conservation of mass
2.2 Models based on law of conservation of energy
2.3 Models based on law of conservation of momentum

3 Heat transfer model **(4 hours)**
3.1 Development of detailed mathematical models of evaporators
3.2 Newton-Raphson method for solving evaporator problems

4 Distillation models **(6 hours)**
4.1 Compartmental models
4.2 Equation of state models
4.3 Activity coefficient models

5 Reactor Modeling **(6 hours)**
5.1 Modeling flow, heat and reaction in reactors
5.2 Batch reactor model
5.3 Continuous stirred tank reactor models
5.4 Bioreactor models

6 Numerical simulations of chemical engineering systems **(9 hours)**
6.1 Introduction and classification of ODEs and PDEs
6.2 Numerical solution of Navier Stokes equation
6.3 Numerical solution to heat and mass transfer system
6.4 Sensitivity analysis concepts
6.5 Simulation of chemical process equipment

7 Artificial Intelligence-based models **(4 hours)**
7.1 Neural network models
7.2 Training of ANN models
7.3 Performance of ANN models
7.4 Applications of ANNs in Chemical Engineering

Practical:
1. CSTR and tubular reactor modeling
2. Diffusion and heat conduction simulation
3. ANN modeling and simulation
4. Mass transfer modeling
5. Chemical engineering modeling project

References:

1. A. K. Jana, "Chemical Process Modelling and Computer Simulation", PHI Learning Private Limited, 2011.
2. A. Rasmuson et al., "Mathematical Modeling in Chemical Engineering", Cambridge University Press, 2014.
3. A. K. Verma, "Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering", CRC Press, 2015.

Evaluation Scheme:
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as follows

:

Unit	Chapter	Topics	Marks
1	1	all	16
2	2	all	16
3	3 & 4	all	16
4	5 & 7	all	16
5	6	all	16
Total			80

Chemical Engineering Design II

EC 701

Lecture: 3 **Year: IV**
Tutorial: 1 **Part: I**

Course Objectives:

i. Acquire understanding of design parameters.
ii. Use of simulation software for process equipment design.

1. Shell - Tube heat exchangers (10 hours)

1.1 Basic design procedure of heat transfer equipment
1.2 Overall heat transfer coefficient and fouling factors
1.3 Construction details for shell & tube heat exchangers
1.4 Design Considerations for shell & tube heat exchangers
1.5 Heat transfer coefficients and pressure drop
1.6 CAD of heat exchangers – shell & tube heat exchangers
1.7 Heat exchanger specification sheet

2. Condensers (6 hours)

2.1 Design of single vapor condensers
2.2 Heat transfer coefficient correlations for vertical and horizontal condensers
2.3 Design of desuperheater cum condenser
2.4 Design of condenser cum sub cooler
2.5 Condensation of mixtures
2.6 Pressure drop in condensers
2.7 Condenser specification sheet

3. Reboilers, vaporizers and evaporators (8 hours)

3.1 Pool and convective boiling
3.2 Design and selection of reboilers, vaporizers and evaporators
3.3 CAD drawing of evaporators
3.4 Reboilers, vaporizers and evaporators specification sheet

4. Distillation column (9 hours)

4.1 Basic design considerations of distillation column
4.2 Degree of freedom analysis
4.3 Design considerations of multi-component distillation
4.4 Plate efficiency
4.5 Tray hydraulics of sieve and valve trays
4.6 CAD design of distillation column
4.7 Distillation column specification sheet

5. Packed column (8 hours)

5.1 Types of packing
5.2 Calculation of packed bed height and diameter
5.3 Column Internals types
5.4 Design of liquid-liquid extraction column
5.5 Packed column specification sheet

6. Miscellaneous equipments (4 hours)

6.1 Design of crystallizers
6.2 Design of gas-liquid separators
6.3 Design of agitated vessels and selection of agitators
6.4 Design of mixing equipment

References:

1 R. K. Sinnott, “Coulson & Richardson’s chemical engineering design”, Volume 6, Elsevier Butterworth-Heinemann. 2012.
2 D. Green, M. Z. Southard, “Perry's Chemical Engineers' Handbook”, McGraw Hill, 2018.
3 S. B.Umarji V. V. Mahajani, “Joshi's Process Equipment Design”, Trinity Press, Laxmi Publication Pvt. Ltd.
4 J. D. Seader, E. J. Henley, “Separation process principles”, Wiley – India. 2006.
5 I. S.: 4503 -1967, “Indian standard specification for shell & tube type heat exchangers. 1983.
6 G. F. Hewitt, G. L. Shires, T. R. Bott, “Process heat transfer”, Begell House, 1994.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as follows:

Unit	Chapter	Topics	Marks
1	1	all	16
2	2 & 6	all	16
3	3	all	16
4	4	all	16
5	5	all	16
Total			**80**

Mining and Mineral Engineering (Elective II)
EC 704

Lecture: 4 **Year: IV**
Practical: 1.5 **Part: I**

Course Objective

- i To obtain fundamental knowledge of the mining industry and geology of mineral deposits
- ii To understand the principles of mine surveying, design, excavation, mine management and mineral processing
- iii To comprehend the characteristics of minerals and their formations in the earth, reserve estimation, and mining law of Nepal.

1. Mining industry (3 hours)

1.1 Basic concept of the mining industry
1.2 Characteristics of mining industry and associated risks

2. Mining geology (6 hours)

2.1 Crystal, mineral, rock, and ore
2.2 Major geological structures
2.3 Formation of mineral deposits
2.4 Geological criteria and guides for prospecting of mineral deposits
2.5 Mineral exploration stages and techniques

3. Underground mining methods and design (8 hours)

3.1 Description and usage of the various underground mining methods
3.2 Requirements for mining development and services
3.3 Underground mining design including surveying and modeling

4. Mine management (5 hours)

4.1 Concept of mine economics, mine valuation, mining costs and cost-benefit analysis, market survey
4.2 Planning of light, drainage and ventilation
4.3 Dewatering and tailings disposal management

5. Mineral processing (8 hours)

5.1 Scopes, objectives and limitations
5.2 Basics of mineral processing including ore handling. sampling theory
5.3 Ore beneficiation
5.4 Selection of method and equipment for concentration
5.5 Ore sorting

6. Health, safety and risk management (5 hours)

6.1 Mine atmosphere and gases, their occurrence and physiological effects
6.2 Fire, explosion and inundation; emissions
6.3 Dust classification, monitoring, and control
6.4 Heat and humidity
6.5 Miners' diseases
6.6 Radiation monitoring and control
6.7 Equipment hazards, noise, illumination
6.8 Personal health and safety, disaster management

7. Mine reclamation and environmental management (5 hours)

7.1 Statutory and regulatory controls on the mining environment
7.2 Air, water and land pollutants, standards, monitoring systems, and prevention and control techniques
7.3 Unique environmental issues
7.4 Environment protection act (2019)

8. Mineral resources promotion and administration (5 hours)

8.1 Potential mineral resources and the current status of the mining industry in Nepal
8.2 Sustainable development of mines and minerals
8.3 Nepalese act on mines and minerals.

Note: There will be one field visit and presentation.

References:

1. S. C. Ray, I. N. Sinha, “Mine and mineral economics”, PHI Learning Pvt. Ltd., Delhi, 2016.
2. V. M. Kreiter, “Geological prospecting and exploration”, University Press of the Pacific, 2004.
3. M. L. Jensen, A. M. Bateman, “Economic mineral deposits”, Wiley, New York, 1979.
4. H. L. Harman, J. M. Mutmansky, “Introductory mining engineering”, New Jersey: John Wiley, 2002.
5. B. A. Wills, J. Finch, “Wills' mineral processing technology: an introduction to the practical aspects of ore treatment and mineral recovery”, Elsevier Science & Technology Books, 2006.
6. Mines and Minerals Act, 1985.
7. Environment Protection Act, 2019.

Practical:

1. Study of industrial minerals in hand specimens.
2. Study of ores in hand specimens.
3. Study of common rocks in hand specimens.
4. Preparation of mineral maps of Nepal.
5. Estimation of limestone reserves based on borehole data.
6. Mine planning
7. Study of the particle size distribution of a sand sample.
8. To study the separation of ore by the flotation method.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	all	16
2	3	all	16
3	4 & 6	all	16
4	5	all	16
5	7 & 8	all	16
Total			80

Biomaterials (Elective II)
EC 704

Lecture: 4 **Year: IV**
Practical: 1.5 **Part: I**

Course Objective

The goal of the course is to provide an introduction to nanotechnology, the underlying principles, methods of synthesis, fabrication and characterization and recent advances in nanotechnology.

1 Fundamentals of biomaterials (6 hours)

1.1 Introduction to biomaterials, human cell, tissue and organs, biomimetics in biomaterials design
1.2 Biomaterial, types of biomaterials, biocompatibility, biological material, biodegradable material, bioresorbable material, bio-inert material, bio-active material, minimum requirements of biomaterials,
1.3 Surface properties of biomaterials, desirable properties of biomaterial, performance of biomaterials, applications of biomaterials with examples.

2 Metallic & ceramic biomaterials (12 hours)

2.1 Metallic biomaterials: introduction, stainless steel, Co-Cr alloys, Ti-alloys, nitinol, dental metals, corrosion of metallic implants, manufacturing of metallic implants, applications.
2.2 Ceramic biomaterials: introduction, types of ceramics, bio-inert ceramics: alumina, zirconia, carbon, bioresorbable ceramics: calcium phosphate, bioactive ceramics: glass ceramics, applications.

3 Polymeric & composite biomaterials (12 hours)

3.1 Polymeric biomaterials: introduction, basic structures of polymers, polymerization and its types, polyethylene, polypropylene, polyamides, polyacrylates, hydrogel, bone cement, fluorocarbon polymers, silicon rubber, bioactive polymers, biodegradable polymers, applications.
3.2 Composite biomaterials: introduction, dental filling composites & cement, porous composites, fibrous & particulate composites.

4 Tissue engineering (10 hours)

4.1 Introduction of tissue engineering, hard tissue and soft tissue engineering materials, biocompatibility testing: introduction, in-vitro testing, in-vivo testing, hypersensitivity, haemocompatibility, odontocompatibility, osteocompatibility, cytotoxicity, genotoxicity, carcinogenicity.
4.2 Response of biomaterial to human body: blood-biomaterial interactions, biomaterials-tissue interactions, tissue response to implants, inflammation, wound healing, foreign body response, infection and tumorigenesis of biomaterials.

5 Bio-implants & surgical aids (5 hours)

5.1 Stent, vascular grafts, artificial heart valves, inferior vanacava filter, contact lenses, intra-ocular lenses, artificial silicon retina, total hip replacement, total knee replacement, dental implants, suture materials.

Practical:

1. Preparation of Simulated Body Fluid (SBF) and SBF treatment of scaffolding material to show mineralization.
2. Surface modification and study of hydrophilic and hydrophobic properties of engineered scaffold.
3. In-vitro biodegradation measurement of scaffolds using PBS of pH 7.4 under 37 °C.
4. Using of Image J software and measurements for scientific research in the field of biomedical imaging.
5. Preparation of agar gel for regenerative medicine.
6. Biomaterials industry visit and observation.

References:

1 J. Park, R.S. Lakes, “Biomaterials: An Introduction”, Springer, 2007.

2 Q. Chen, G. Thouas, “Biomaterials: A Basic Introduction”, CRC Press, 2016.
3 B. Basu, D. S. Katti, A. A. Kumar, “Advanced Biomaterials: Fundamentals, Processing, and Applications”, John Wiley and Sons 2009.
4 B. D. Ratner, A. S. Hoffman, F. J. Schoen, J E Lemons, “Biomaterials Science: An Introduction to materials in medicine”, Academic Press.
5 A Laboratory Course in Biomaterials, ISBN 9781420075823, Published June 24, 2009 by CRC Press.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	all	8
2	2	all	24
3	3	all	24
4	4	all	16
5	5	all	8
Total			80

Pharmaceutical Engineering (Elective II)
EC 704

Lecture: 4 **Year: IV**
Practical: 1.5 **Part: I**

Course objectives:

i. This course is structured to introduce pharmaceutics, its related constituents, technologies and applications for Chemical Engineers.
ii. The contents of this course helps in providing fundamental understanding of the field, the design, development of pharmaceutical products and processes, including drug discovery, formulation, dosage form design and manufacturing.

1 Introduction to pharmaceutical engineering (5 hours)

1.1 Overview of the pharmaceutical industry in Nepal.
1.2 Introduction to drug discovery, development, and manufacturing.
1.3 Role of chemical engineers in the pharmaceutical API processes.
1.4 Introduction to green chemistry and green processes in the pharmaceutical industry.
1.5 Introduction to drug act & regulations of Nepal.

2 Pharmacokinetics and drug delivery systems (12 hours)

2.1 Basic pharmacokinetics and pharmacodynamics.
2.2 API and Pharmaceutical additives.
2.3 Drug absorption, distribution, metabolism, and elimination.
2.4 Drug delivery systems: types, formulation, and characterization.
2.5 Drug dosage forms: solid, liquid, parenteral, biologicals.
2.6 Controlled drug release systems.
2.7 Targeted drug delivery systems.
2.8 Non-invasive drug delivery systems.

3 Pharmaceutical unit operations (8 hours)

3.1 Reaction kinetics and characterization.
3.2 Solid dosage forms: mixing, granulation, compression, coating and packaging.
3.3 Liquid dosage forms: mixing, homogenization, filling and packaging.
3.4 Parenteral dosage forms: aseptic processing, filling and sterilization.
3.5 Biologicals manufacturing: cell culture, fermentation, upstream and downstream processing.
3.6 Unit operation case studies.

4 Pharmaceutical biotechnology (10 hours)

4.1 Introduction to pharmaceutical biotechnology.
4.2 Recombinant DNA technology and genetic engineering in pharmaceuticals.
4.3 Biopharmaceutical production systems: Bio-production of insulin, vaccines.
4.4 Monoclonal antibody technology.
4.5 Biosimilars and biobetters.
4.6 Gene and cell therapy.

5 Advanced pharmaceutical formulations (10 hours)

5.1 Introduction to advanced pharmaceutical formulations.
5.2 Micro- and nano-particulate drug delivery systems.
5.3 Liposomes and niosomes.
5.4 Dendrimers and other polymeric nanoparticles.
5.5 Self-emulsifying drug systems.
5.6 Colloidal drug systems.
5.7 Pharmaceutical quality control testing, analysis.

Practical

1 Identification of organic compounds based on solubility and functional group test.
2 Performance of qualitative test for alkaloids, steroids and others.
3 Assay of selected compounds of pharmaceutical importance: Test for analysis of selected drugs: Paracetamol, Metformin.
4 Size analysis by sieving: To determine the particle size distribution of powder (aspirin/calamine or Calcium Carbonate) by sieving method.
5 Preparation of alcohol based hand sanitizer.
6 Pharmaceutical industry visit and report writing.

References

1 N. K. Jain, S. Sharma, "Textbook of Professional Pharmacy", Vallabh Publications, 2016.
2 J. P. Remington, "The Science and Practice of Pharmacy", Pharmaceutical Press, 2020.
3 L. Lachman, H. A. Liebermann, "The Theory and Practice of Industrial Pharmacy", CBS Publishers & Distributors Pvt. Limited, 2020.
4 S. K. Jain, V. Soni, "Bentley's Textbook of Pharmaceutics" Elsevier India, 2011.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 3	all	24
2	2	all	24
3	4	all	16
4	5	all	16
Total			**80**

Project I
EC 709

Practical: 3 | **Year: IV**
Part: I

Course Objective:

i. To plan and complete chemical engineering design projects.
ii. To write well documented report and give oral examination.

General Procedures:

The project course will involve working on chemical process design related to Chemical Engineering. The topic will be selected in consultation with the supervision of a faculty member in the Department of Applied Sciences and Chemical Engineering.

The students are advised to select the topics at the beginning of the seventh semester. The consultation hour of supervisor will be three hours per week. There will be 4 students per group in a project.

Course Requirements:

A detailed project proposal is to be submitted to the department at the beginning of the term. After the acceptance of the topics by the department, there will be proposal defense. Each group have to submit written report and present their topics to the committee formed by the department.

For the end term evaluation, each group have to submit written report and present their work to the committee formed by the department. It will be evaluated as per the schedule of examination control division (ECD), IOE, at the end of the seventh semester.

10 marks are allocated for proposal defense and 40 marks for end term.